

Particle Transport From the Magnetosphere's Low-Latitude Boundary Layer

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The interaction between solar and terrestrial magnetospheric plasmas takes place through a diffuse boundary layer across which properties of the two plasma regimes gradually merge. Several modeling studies have addressed the question of the relative contribution, throughout the magnetosphere, of the solar wind particles able to penetrate the Earth's magnetic protective layers relative to those magnetospheric particles that originate in the ionosphere. For example, Delcourt et al¹. examined dayside magnetopause entry points for solar wind protons and traced their dayside-to-nightside transport over the polar cap. This study found an inward limit of solar wind plasma penetration as a direct consequence of the field-line topology.

Here we examine the questions of whether solar wind and ionospheric plasma of the low-latitude boundary layer, streaming tailward, can play a significant role in the transport of plasma from the magnetosheath to the central plasma sheet.

This survey considers particle behavior in Tsyanenko and Modified Volland fields. Two broad classes of particles are included, representing solar plasma and ionospheric plasma as separate ranges of initial velocities (in the plasma convection frame). During steady conditions, solar and

ionospheric populations convected into the low-latitude boundary layer exhibit the behaviors discussed below.

Precipitation along magnetic field lines into the ionosphere are found to be associated with large initial ratios of parallel-to-perpendicular particle velocity, but also occur after evolution of a trajectory in which large magnetic-moment decrease or parallel acceleration occurs. Ionospheric protons, because of their smaller initial parallel velocities, are less likely to be precipitated than solar protons.

Plasma escape downstream in the magnetotail occurs mainly in the outer layers of the low-latitude boundary layer, and occurs further inward along the dusk flank than for the dawn flank, largely because of the asymmetric effects of gradient and curvature drifts.

Plasma trapping and transport to the inner magnetosphere occurs for both solar wind and ionospheric populations, and many particles enter long-term convection trapping. Trapping appears as prolonged bouncing motions during convection along the magnetopause, during which the particles lose energy steadily, prior to ultimate escape. Particles with larger magnetic moments drift more rapidly inward along the dawn flank and outward along the dusk flank. Those drifting sufficiently inward are returned earthward through the plasma sheet, generally gaining significant energy during that phase of their motion. Some particles enter closed convection paths that have the potential for long-term trapping in the convection cell vortices. Bounce phase variations lead to considerable aperiodicity in these trajectories, even

though they may be closed in a larger sense.

Energization to ring-current energies occurs for some protons originating in the low-latitude boundary layer—mainly those protons that begin earthward convection sufficiently duskward within the plasma sheet or that gain sufficient magnetic moment in their earthward transit. Particles that begin earthward convection sufficiently duskward within the plasma sheet or that gain sufficient magnetic moment in their earthward transit travel generally duskward and reach very high energies (10's of kiloelectron volts) in the inner magnetosphere, forming a ring-current contribution.

In summary, the low-latitude boundary layer is found to be a more effective source of solar plasma to the plasma sheet than the high-latitude plasma mantle. Ionospheric plasma convected into the low-latitude region is also delivered in part to the plasma sheet, where it is energized.

¹Delcourt, D.C.; Moore, T.E.; Sauvaud, J.A.; and Chappell, C.R. 1992. Nonadiabatic Transport Features in the Outer Cusp Region. *Journal of Geophysical Research*, 97:16, 883.

²Moore, T.E.; Giles, B.L.; and Delcourt, D.C. 1994. Particle Transport From the Low-Latitude Boundary Layer. *EOS Transactions*, American Geophysical Union.

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